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ABSTRACT

This paper discusses three studies which examined the interaction of dimensional dominance with the attentional components of alertness and encoding. In Study I, twenty 6- and 7-year-olds observed thirty 3-second exposures of a color, then participated in a 40-trial choice reaction time task in which the familiarized color and a novel color served as warning signals. Results supported the hypothesis that the stimulus familiarization effect (familiar stimuli elicit slower responses than do novel stimuli) is a result of a decrease in the alerting value of that stimulus. In Study II, 20 first graders were familiarized to a color and then given 40 choice reaction time trials in which the familiar color and novel color served as response cues. An unrelated warning signal was also used just prior to each response cue to insure maximum alertness, regardless of the stimulus that followed. Results showed that a positive encoding effect could be observed when the alertness decrement was by-passed. In Study III, 22 kindergarteners were familiarized to a colored shape and were then given 36 straight reaction time trials with one of two shapes of one of two colors. A color-form preference test was also given to determine dimensional dominance. The results indicated that the familiarized stimulus was responded to more slowly than the completely different stimulus and that response speeds to partially different stimuli varied as a function of dimensional dominance. Findings from these studies are discussed in terms of the relationship between perception and cognition. (JMB)

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A Technique for Investigating Attention in Children

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I'd like to describe a simple experiment in perception. A 6- or 7-year old child is brought to a small testing room and shown 30 or so brief presentations of a colored slide. (Slide 1). The child does nothing but look at the slide each time it is presented. This familiarized color and a different color are then used as response cues in a choice reaction time task; the familiarized color is the response cue for half of the trials and the novel color for the remaining trials. What has been found in more than a dozen studies of this type is that the familiarized color is responded to more slowly than the novel color. A group of researchers headed by Gordon Cantor have termed this result the stimulus familiarization effect. A typical finding is shown here (Slide 2).

I became interested in trying to account for this effect within the context of attention. Specifically, a model of attention proposed by Michael Posner and Stephen Boies seemed to me to provide a framework for such an explanation. According to the model, one way of conceiving of attention is in terms of alertness or arousal. Alertness refers to processes responsible for developing and maintaining a general readiness to respond. Empirically, Posner and Boies have demonstrated that levels of alertness can be manipulated as a function of a warning signal in a reaction time task. For example, subjects become more alert, as reflected by faster reaction times, when a warning signal precedes a response cue than if no warning signal is present.

Alertness was also thought to be involved in the stimulus familiarization effect. Slow responses to a familiarized stimulus could be a result of a decrease in the alerting value of that stimulus.

In a test of this alertness decrement hypothesis, 20 6- and 7-year olds first observed 30 3-sec exposures of a color. The children then participated in a 40 trial choice reaction time task in which the familiarized color and a novel color served as warning signals. The response cues, a triangle and an inverted T, were randomly paired with one of the warning signals on every trial so that a particular warning

signal gave no information about which response cue was to follow.

The results of the experiment, shown in the next slide, supported the alertness decrement hypothesis (Slide 3). Responses were slower after a familiar warning signal and the effect persisted for 40 trials.

As some kind of a simple perceptualphenomenon, the stimulus familiarization effect appears to have been explained. At least in part, it reflects a decrease in alertness. But, explained or not, there is still something counterintuitive about the effect of familiarization on attention. Why should something that has been presented many times be responded to slowly? Shouldn't it be that the more something is presented the better it is known, and the better something is known the faster it is attended to? This reasoning indicates that familiar things should be responded to faster rather than slower.

Not at all coincidentally, the Posner and Boies model of attention offers empirical support for this idea in dealing with a second aspect of attention termed encoding. Encoding refers to the selective nature by which specific information is used. In a series of reaction time tasks Posner and Boies demonstrated that two consecutively presented identical stimuli are responded to faster than any other non-identical pair. The interpretation is that repeating an encoding operation just previously used is more efficient and elicits faster reaction times than activating a relatively novel operation.

With respect to the familiarization procedure this suggests that presenting the familiarized stimulus during test should result in its being encoded more easily than a novel stimulus and, so, in its being responded to faster than a novel stimulus.

The problem with this prediction is that, as just described, familiarized stimuli, in fact, elicit slower responses than novel stimuli. However, on the basis of the previous experiment it was assumed that this slowdown is due to an alertness decrement and hypothesized that if this alertness decrement could be by-passed, a positive encoding effect would be found.

This was accomplished in an experiment in which 20 first graders were initially familiarized by observing 30 3-sec exposures of a color. The familiarized color and novel color then served as response cues in a 40 trial choice reaction time task. Also, an unrelated warning signal occurred 600 msec prior to each response cue. Its purpose was to raise alertness so that alertness was at an optimal level regardless of the stimulus that followed.

Using the warning signal, the hypothesis that familiarization facilitates encoding was supported. Responses were faster to the familiarized stimulus (Slide 4).

The sum of these experiments suggests a complex attentional system in the young child; a system in which alertness and encoding serve independent functions. Alertness seems to be affected by the general warning value of a visual array. Encoding appears to be affected by the specific information extracted from an array. The processes that control alertness and encoding are sensitive even to the simple information contained in these colored slides. Moreover, the familiarization procedure provides a way of investigating alertness and encoding. In this case, familiarization accounts for a negative alertness effect and a positive encoding effect.

But consider now a stimulus composed of two components. Actually, the first slide you saw provides an example if we consider it to be a blue circle instead of just the color blue. For a two component stimulus three types of stimuli can be constructed that differ from it (Slide 5). One type consists of different values on both the color and form dimension such as the red square you see in the slide. The other two types consist of changes in the value of one dimension but not the other. For example, the red circle represents a difference in color but not form and the blue square represents a difference in form but not color.

Suppose the blue circle the familiarized stimulus. If it is then contrasted in a reaction time task with a stimulus which differs from it on both dimensions (the red square), we would predict slower responses to the familiarized stimulus. This, again, is the stimulus familiarization effect but with a two dimensional stimulus.

What about responses to the two partially different stimuli: the red circle and the blue square? In each case one component is the same as the familiarized stimulus. On the basis of the previous experiments, an encoding advantage might be expected for this component -- that is, it might elicit faster responses. Also, in each case, one component is different from the familiarized stimulus. Again, on the basis of the previous experiments, a positive alertness effect might be expected for this component. That is, it also might be responded to quickly. So, both partially different stimuli should produce the same effects, response speeds should be the same to both.

If, however, the salience of the stimulus dimensions represented by the two components differed, there might be a reason to expect different response speeds to the two partially different stimuli. Suppose it is assumed that during familiarization a more salient component receives greater encoding than a less salient component. In other words, that a form dominant subject familiarized to the blue circle encodes circle more than blue. Of the two partially different stimuli, the red circle retains the same form as the familiarized stimulus, whereas the blue square does not. So a greater positive encoding effect would be expected for the red circle. Stated more generally, response speeds might be expected to be faster to partially different stimuli for which the more salient dimension remains the same than to partially different stimuli for which the less salient dimension remains the same.

Dan Smothergill and I tested this hypothesis. Twenty-two kindergarteners were familiarized to one of the four stimuli you see in the slide. This was followed by a series of 36 straight reaction time trials. On each trial any one of these four stimuli was the response cue. Subjects were instructed simply to press a single response button each time a stimulus was presented.

At another time, each subject was given a color-form preference test to determine degree of color and form dominance. Three colored forms were arranged in a

triangle on each of 16 cards. The one at the top of the card was regarded as the standard and the other two as alternatives. One alternative was the same color as the standard and the other was the same form. On each card the subject was asked to select the alternative that was more like the standard. Each selection on the basis of form was scored +1 and each selection on the basis of color was scored -1.

One prediction for this experiment was that the familiarized stimulus would be responded to more slowly than the completely different stimulus. This prediction was supported.

The more important prediction was that response speeds to the two partially different stimuli would vary as a function of dimensional dominance. To test this, each subject's mean response speed in the condition in which color remained the same was subtracted from his mean response speed in the condition in which form remained the same. These scores were then correlated with scores from the dimensional preference test. The foregoing hypothesis would suggest that a correlation should be obtained and it was, significant at the .05 level. Subjects who responded faster to stimuli in which form remained the same were relatively more form dominant and subjects who responded faster to stimuli in which color remained the same were relatively more color dominant.

A second analysis in which response speeds in the two partially different conditions were treated as separate variables and the dimensional dominance score was used as a covariate also supported this finding.

This research has added to our understanding of dimensional dominance and attention. Specifically, the research suggests that dimensional dominance interacts with the attentional components of alertness and encoding. A dimension that is salient to a child appears to affect encoding more than alertness.

But the research also addresses a larger issue: the relation between perception and cognition in the developing child. I think that most researchers would agree that

the areas of perception and cognition overlap. Research, however, generally follows the distinction that perceptual processes are invoked when stimuli are physically present and conceptual processes are invoked when stimuli are not. Somehow, perception occurs between the eye and the world while cognition occurs within the mind. This exact relation between the two processes is generally left unspecified.

Using this traditional distinction, the familiarization effect was first described as a simple perceptual phenomenon. A child responds slowly to a familiar stimulus. But the traditional view of perception doesn't seem to account for the full effects of familiarization.

Consider what goes on during encoding. The dimensional dominance study suggested that the information obtained from a familiar visual array is encoded according to hierarchies of preference present in the child. This seems a very cognitively oriented view of encoding. But if cognition is involved, where does cognition stop and perception begin? Is it that the child perceives the array according to the way the mind is ordered or that the mind is ordered according to the way the child perceives the array?

The point of asking these questions is to suggest that, perhaps, there are no definitive answers, that the distinction between perception and cognition becomes unclear in investigating attentional processes in children. Considering encoding, it is not even clear just what the psychological differences are between perception and cognition.

It is suggested here that the familiarization procedure can serve to further our understanding of the child as a complete mental entity. What are generally considered cognitive tasks can be looked at from a perceptual viewpoint and what are considered perceptual tasks can be looked at from a cognitive viewpoint. For example, a number of experiments have been conducted over the past few years to determine if children encode words according to formal categories. That is, is the word hand encoded along the category parts of the body? Many of these experiments have employed a short-term memory paradigm, borrowed from the adult literature, known as release from proactive inhibition. In a typical experiment, two or three words from a single category, such as parts of the

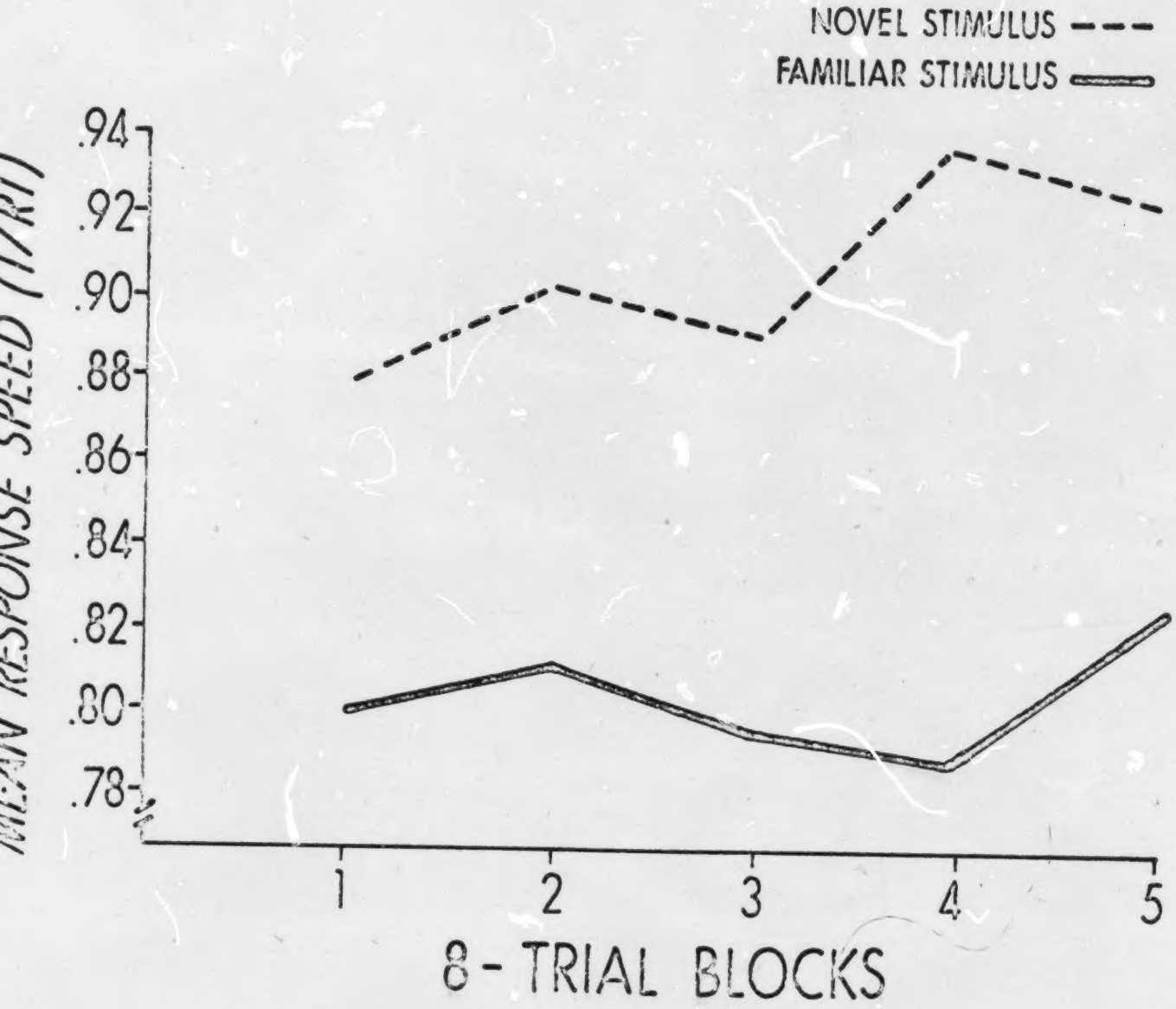
body, are presented briefly to subjects. Following a 20 sec distraction period, subjects are asked to recall the words. Two similar trials follow in which new words from the same category are presented for recall. A fourth and final trial then occurs. On this final trial, words from a second category such as animals are presented.

Encoding according to categories is indicated first, by a steady decline in recall across the first three trials when words from the same category are to be remembered, and second, by an increase in recall on the final trial when words from a new category are to be remembered. The assumption is that there is a build up of proactive inhibition across the first three trials when a common encoding operation is used for different values of one category, and a release from a proactive inhibition on the final trial when a new encoding operation is used.

The release from proactive inhibition paradigm has come to be accepted as a technique for studying encoding in children. The results usually have been interpreted in terms of memory processes and memory is regarded by many as a form of cognition. But what if the familiarization procedure could be adapted to investigate this type of encoding, as I think it could be. Children might be familiarized to a series of words selected from a single category. A subsequent reaction time task could contrast a novel word selected from the familiar category with a novel word selected from a second category. If it were found that faster responses occurred to words from the familiar category, this would indicate that the category had been encoded during familiarization. I would then say that the category had been attended to during familiarization. That might sound strange since the term attention is more traditionally reserved for concrete objects, such as these colored forms. But this traditional way of thinking is part of a theory which holds that perception deals only with concrete things and Eleanor Gibson, among others, has argued that perceptual development consists of detecting abstract invariants in the world that don't at all fit our usual notion of concrete. So perhaps we should be thinking of attention as a perceptual-cognitive process and begin facing up to the hard question of what the differences are, if any, between perceptual and cognitive functioning.

Blue

FAMILIARIZED STIMULUS
Presented for 30 2- to 3- sec exposures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FAMILIAR STIMULUS
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2
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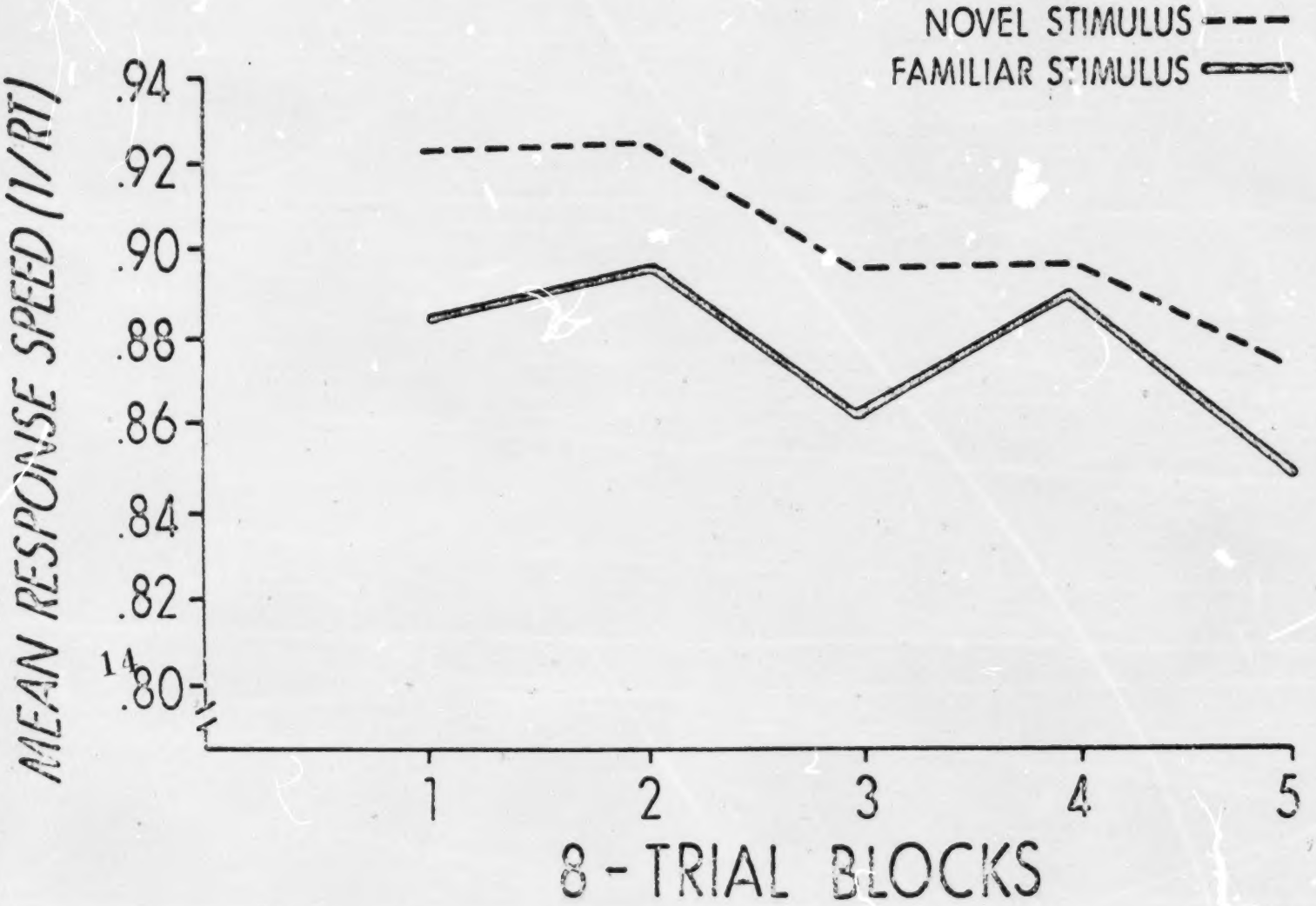
4
5
8 - TRIAL BLOCKS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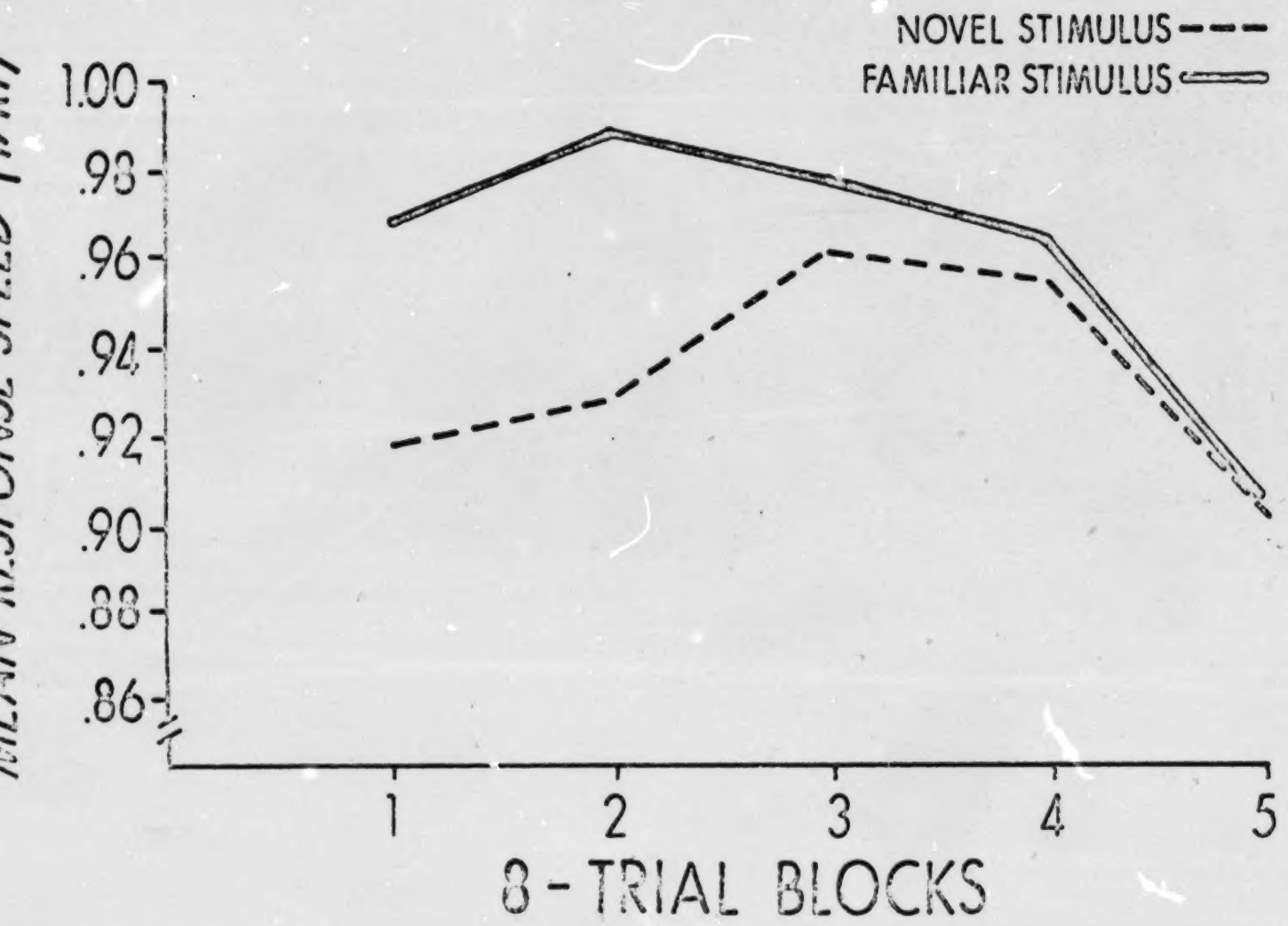
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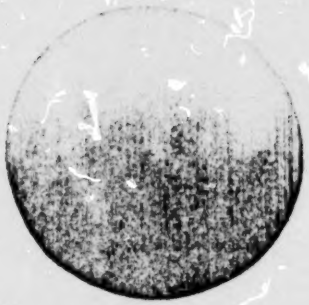
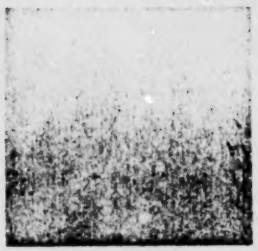


Blue

COMPLETELY FAMILIAR

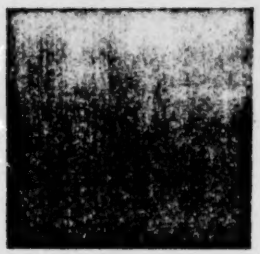
Red

DIFFERENT COLOR/
FAMILIAR FORM



Blue

FAMILIAR COLOR/
DIFFERENT FORM



Red

COMPLETELY DIFFERENT